

## N - CHANNEL ENHANCEMENT MODE

## FAST POWER MOS TRANSISTOR

| TYPE        | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|-------------|------------------|---------------------|----------------|
| STP10NA40   | 400 V            | < 0.55 $\Omega$     | 10 A           |
| STP10NA40FI | 400 V            | < 0.55 $\Omega$     | 6 A            |

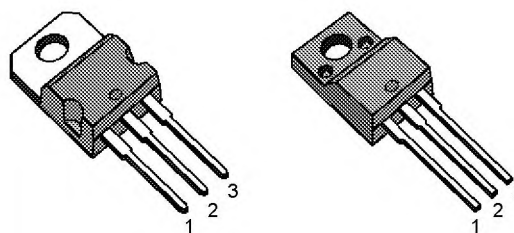
- TYPICAL R<sub>DS(on)</sub> = 0.46  $\Omega$
- $\pm 30$ V GATE TO SOURCE VOLTAGE RATING
- 100% AVALANCHE TESTED
- REPETITIVE AVALANCHE DATA AT 100°C
- LOW INTRINSIC CAPACITANCES
- GATE CHARGE MINIMIZED
- REDUCED THRESHOLD VOLTAGE SPREAD

### DESCRIPTION

This series of POWER MOSFETS represents the most advanced high voltage technology. The optimized cell layout coupled with a new proprietary edge termination concur to give the device low R<sub>DS(on)</sub> and gate charge, unequalled ruggedness and superior switching performance.

### APPLICATIONS

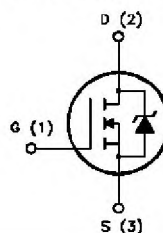
- HIGH CURRENT, HIGH SPEED SWITCHING
- SWITCH MODE POWER SUPPLIES (SMPS)
- DC-AC CONVERTERS FOR WELDING EQUIPMENT AND UNINTERRUPTIBLE POWER SUPPLIES AND MOTOR DRIVE



TO-220

ISOWATT220

### INTERNAL SCHEMATIC DIAGRAM



### ABSOLUTE MAXIMUM RATINGS

| Symbol              | Parameter                                             | Value      |             | Unit |
|---------------------|-------------------------------------------------------|------------|-------------|------|
|                     |                                                       | STP10NA40  | STP10NA40FI |      |
| V <sub>DS</sub>     | Drain-source Voltage (V <sub>GS</sub> = 0)            | 400        |             | V    |
| V <sub>DGR</sub>    | Drain-gate Voltage (R <sub>GS</sub> = 20 k $\Omega$ ) | 400        |             | V    |
| V <sub>GS</sub>     | Gate-source Voltage                                   | $\pm 30$   |             | V    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>c</sub> = 25 °C  | 10         | 6           | A    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>c</sub> = 100 °C | 6.3        | 3.8         | A    |
| I <sub>DM</sub> (•) | Drain Current (pulsed)                                | 40         | 40          | A    |
| P <sub>tot</sub>    | Total Dissipation at T <sub>c</sub> = 25 °C           | 125        | 45          | W    |
|                     | Derating Factor                                       | 1          | 0.36        | W/°C |
| V <sub>ISO</sub>    | Insulation Withstand Voltage (DC)                     | —          | 2000        | V    |
| T <sub>stg</sub>    | Storage Temperature                                   | -65 to 150 |             | °C   |
| T <sub>j</sub>      | Max. Operating Junction Temperature                   | 150        |             | °C   |

(•) Pulse width limited by safe operating area

## STP10NA40/FI

### THERMAL DATA

|                |                                                | TO-220 | ISOWATT220 |               |
|----------------|------------------------------------------------|--------|------------|---------------|
| $R_{thj-case}$ | Thermal Resistance Junction-case Max           | 1      | 2.78       | $^{\circ}C/W$ |
| $R_{thj-amb}$  | Thermal Resistance Junction-ambient Max        | 62.5   |            | $^{\circ}C/W$ |
| $R_{thc-sink}$ | Thermal Resistance Case-sink Typ               | 0.5    |            | $^{\circ}C/W$ |
| $T_l$          | Maximum Lead Temperature For Soldering Purpose | 300    |            | $^{\circ}C$   |

### AVALANCHE CHARACTERISTICS

| Symbol   | Parameter                                                                                                                   | Max Value | Unit |
|----------|-----------------------------------------------------------------------------------------------------------------------------|-----------|------|
| $I_{AR}$ | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by $T_j$ max, $\delta < 1\%$ )                         | 10        | A    |
| $E_{AS}$ | Single Pulse Avalanche Energy (starting $T_j = 25^{\circ}C$ , $I_D = I_{AR}$ , $V_{DD} = 50 V$ )                            | 500       | mJ   |
| $E_{AR}$ | Repetitive Avalanche Energy (pulse width limited by $T_j$ max, $\delta < 1\%$ )                                             | 20        | mJ   |
| $I_{AR}$ | Avalanche Current, Repetitive or Not-Repetitive ( $T_c = 100^{\circ}C$ , pulse width limited by $T_j$ max, $\delta < 1\%$ ) | 6.3       | A    |

### ELECTRICAL CHARACTERISTICS ( $T_{case} = 25^{\circ}C$ unless otherwise specified)

#### OFF

| Symbol        | Parameter                                        | Test Conditions                                                                              | Min. | Typ. | Max.        | Unit               |
|---------------|--------------------------------------------------|----------------------------------------------------------------------------------------------|------|------|-------------|--------------------|
| $V_{(BR)DSS}$ | Drain-source Breakdown Voltage                   | $I_D = 250 \mu A$ $V_{GS} = 0$                                                               | 400  |      |             | V                  |
| $I_{DSS}$     | Zero Gate Voltage Drain Current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max Rating}$<br>$V_{DS} = \text{Max Rating} \times 0.8$ $T_c = 125^{\circ}C$ |      |      | 250<br>1000 | $\mu A$<br>$\mu A$ |
| $I_{GSS}$     | Gate-body Leakage Current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 30 V$                                                                          |      |      | $\pm 100$   | nA                 |

#### ON (\*)

| Symbol       | Parameter                         | Test Conditions                                                               | Min. | Typ. | Max.        | Unit                 |
|--------------|-----------------------------------|-------------------------------------------------------------------------------|------|------|-------------|----------------------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}$ $I_D = 250 \mu A$                                           | 2.25 | 3    | 3.75        | V                    |
| $R_{DS(on)}$ | Static Drain-source On Resistance | $V_{GS} = 10V$ $I_D = 5 A$<br>$V_{GS} = 10V$ $I_D = 5 A$ $T_c = 100^{\circ}C$ |      | 0.46 | 0.55<br>1.1 | $\Omega$<br>$\Omega$ |
| $I_{D(on)}$  | On State Drain Current            | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$<br>$V_{GS} = 10 V$                  | 10   |      |             | A                    |

### DYNAMIC

| Symbol       | Parameter                    | Test Conditions                                       | Min. | Typ. | Max. | Unit |
|--------------|------------------------------|-------------------------------------------------------|------|------|------|------|
| $g_{fs} (*)$ | Forward Transconductance     | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$ $I_D = 5 A$ | 5    | 7.2  |      | S    |
| $C_{iss}$    | Input Capacitance            | $V_{DS} = 25 V$ $f = 1 MHz$ $V_{GS} = 0$              |      | 1180 | 1600 | pF   |
| $C_{oss}$    | Output Capacitance           |                                                       |      | 200  | 260  | pF   |
| $C_{rss}$    | Reverse Transfer Capacitance |                                                       |      | 55   | 75   | pF   |

**ELECTRICAL CHARACTERISTICS** (continued)**SWITCHING ON**

| Symbol                        | Parameter                                                    | Test Conditions                                                                                                          | Min. | Typ.          | Max.      | Unit           |
|-------------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------|---------------|-----------|----------------|
| $t_{d(on)}$<br>$t_r$          | Turn-on Time<br>Rise Time                                    | $V_{DD} = 200\text{ V}$ $I_D = 5\text{ A}$<br>$R_G = 47\ \Omega$ $V_{GS} = 10\text{ V}$<br>(see test circuit, figure 3)  |      | 35<br>115     | 50<br>155 | ns<br>ns       |
| $(di/dt)_{on}$                | Turn-on Current Slope                                        | $V_{DD} = 320\text{ V}$ $I_D = 10\text{ A}$<br>$R_G = 47\ \Omega$ $V_{GS} = 10\text{ V}$<br>(see test circuit, figure 5) |      | 250           |           | A/ $\mu$ s     |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total Gate Charge<br>Gate-Source Charge<br>Gate-Drain Charge | $V_{DD} = 320\text{ V}$ $I_D = 10\text{ A}$ $V_{GS} = 10\text{ V}$                                                       |      | 54<br>8<br>27 | 75        | nC<br>nC<br>nC |

**SWITCHING OFF**

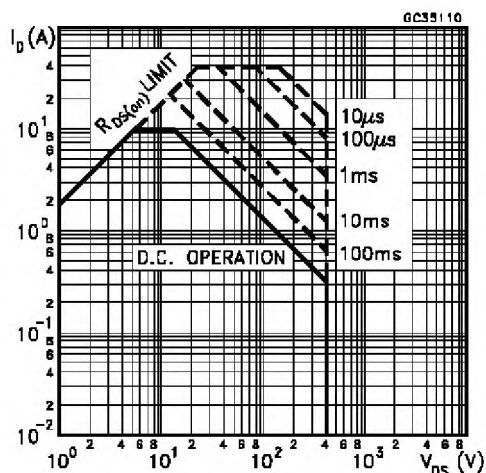
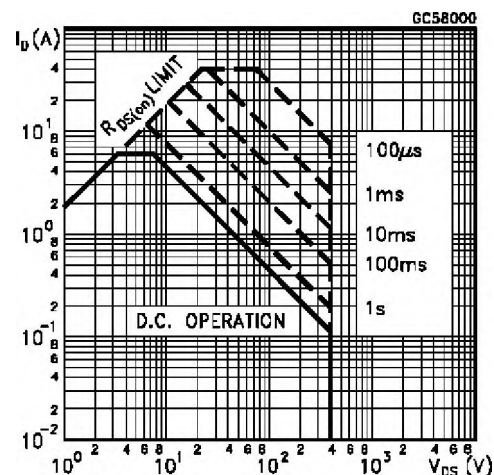
| Symbol                          | Parameter                                             | Test Conditions                                                                                                          | Min. | Typ.            | Max.             | Unit           |
|---------------------------------|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------|-----------------|------------------|----------------|
| $t_{r(Voff)}$<br>$t_f$<br>$t_c$ | Off-voltage Rise Time<br>Fall Time<br>Cross-over Time | $V_{DD} = 320\text{ V}$ $I_D = 10\text{ A}$<br>$R_G = 47\ \Omega$ $V_{GS} = 10\text{ V}$<br>(see test circuit, figure 5) |      | 75<br>30<br>120 | 105<br>45<br>160 | ns<br>ns<br>ns |

**SOURCE DRAIN DIODE**

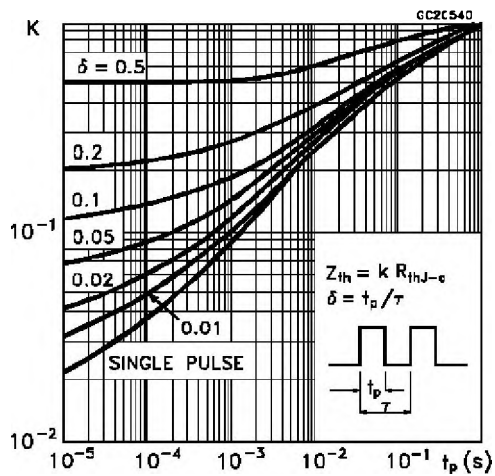
| Symbol                            | Parameter                                                                             | Test Conditions                                                                                                                                        | Min. | Typ.               | Max.     | Unit                     |
|-----------------------------------|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------|----------|--------------------------|
| $I_{SD}$<br>$I_{SDM}(\bullet)$    | Source-drain Current<br>Source-drain Current<br>(pulsed)                              |                                                                                                                                                        |      |                    | 10<br>40 | A<br>A                   |
| $V_{SD} (*)$                      | Forward On Voltage                                                                    | $I_{SD} = 10\text{ A}$ $V_{GS} = 0$                                                                                                                    |      |                    | 1.6      | V                        |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery<br>Time<br>Reverse Recovery<br>Charge<br>Reverse Recovery<br>Current | $I_{SD} = 10\text{ A}$ $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ $T_j = 150\text{ }^\circ\text{C}$<br>(see test circuit, figure 5) |      | 470<br>6.5<br>27.5 |          | ns<br>$\mu\text{C}$<br>A |

(\*) Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %

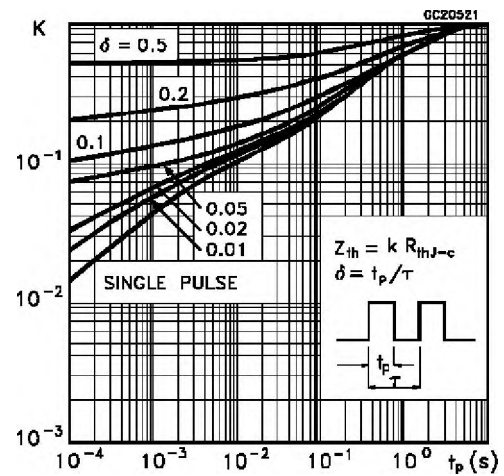
(\bullet) Pulse width limited by safe operating area

**Safe Operating Areas for TO-220****Safe Operating Areas for ISOWATT220**

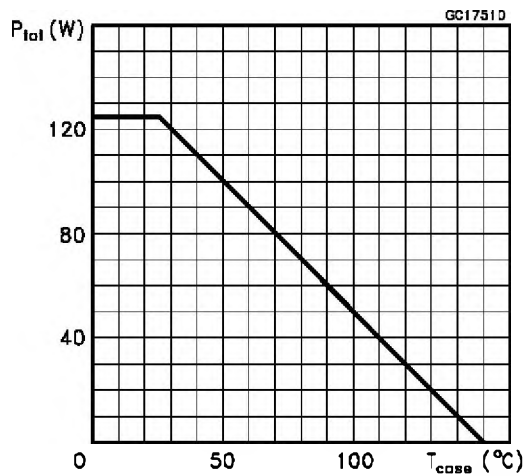
Thermal Impedance For TO-220



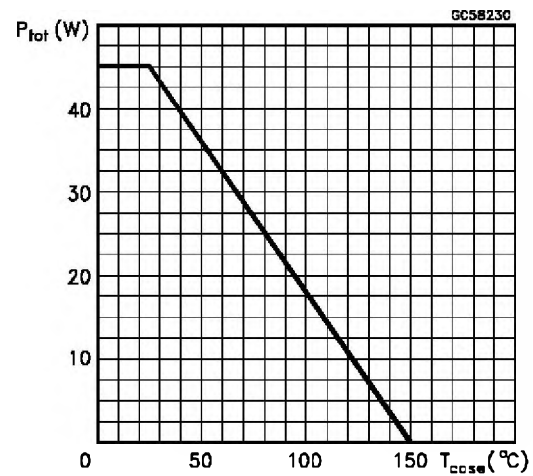
Thermal Impedance For ISOWATT220



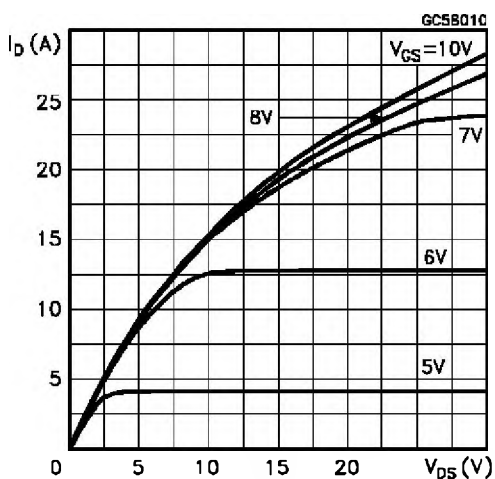
Derating Curve For TO-220



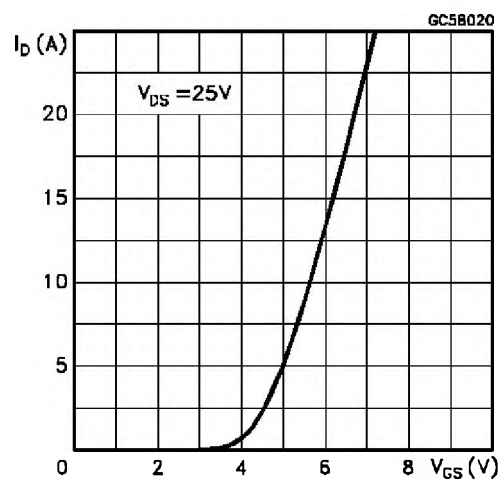
Derating Curve For ISOWATT220



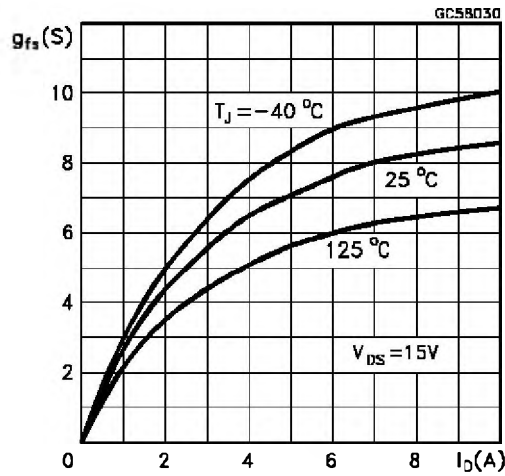
Output Characteristics



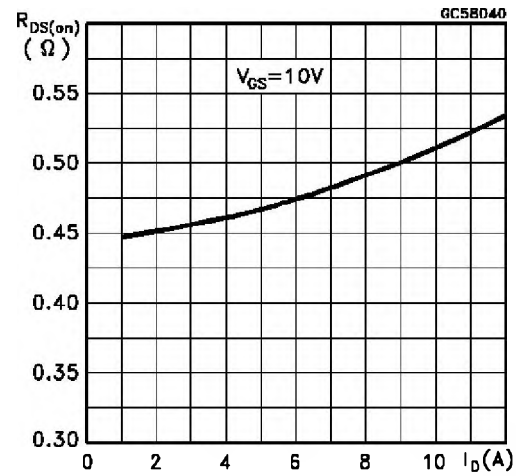
Transfer Characteristics



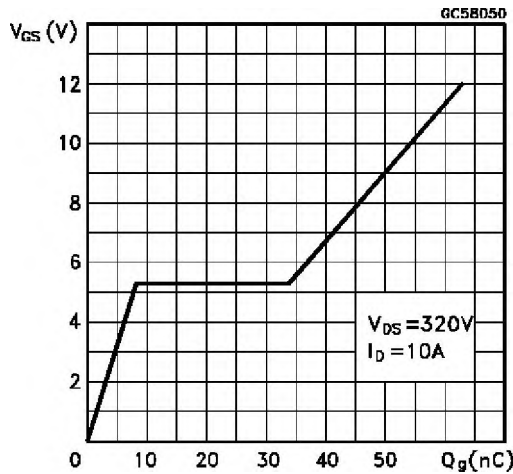
Transconductance



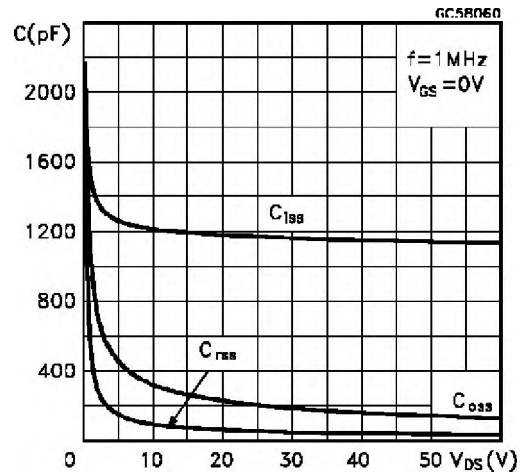
Static Drain-source On Resistance



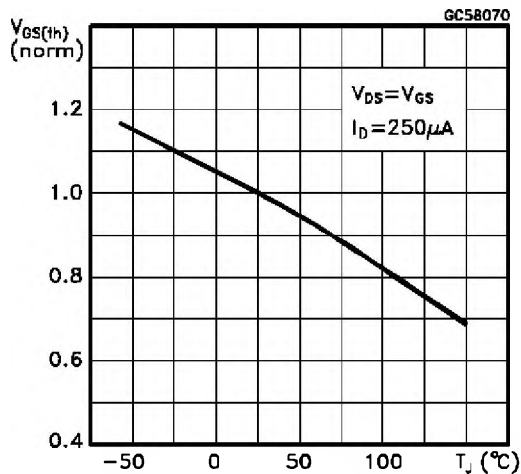
Gate Charge vs Gate-source Voltage



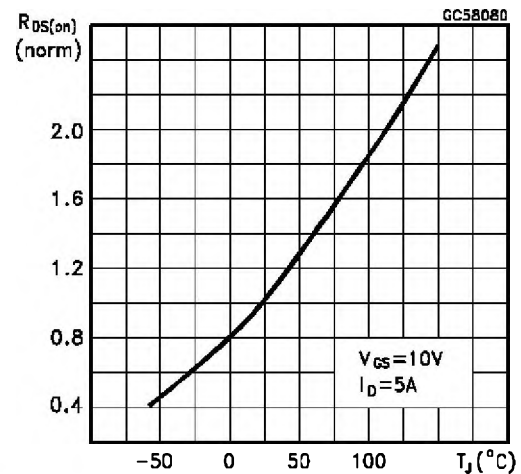
Capacitance Variations



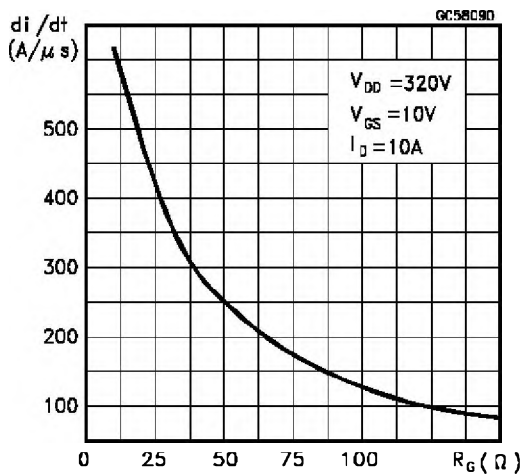
Normalized Gate Threshold Voltage vs Temperature



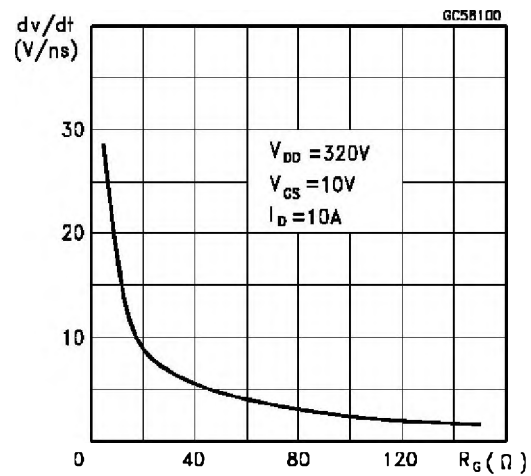
Normalized On Resistance vs Temperature



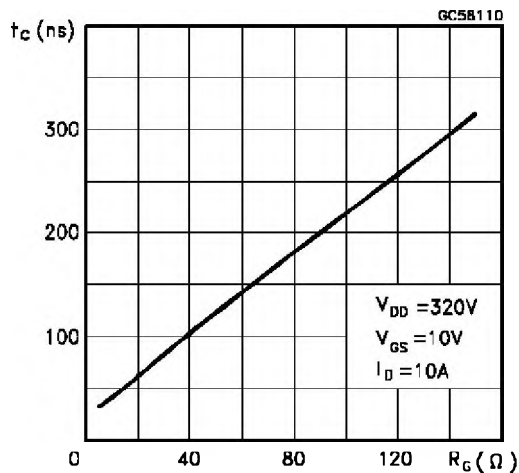
Turn-on Current Slope



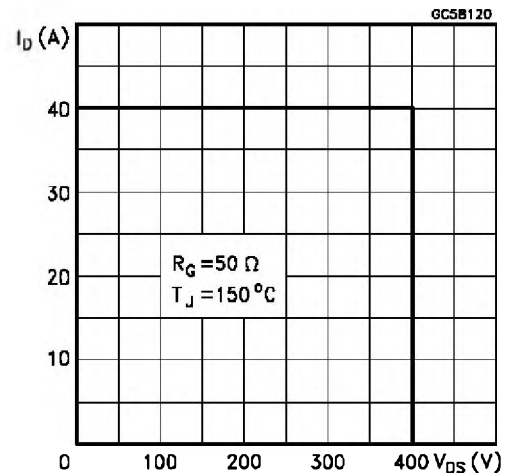
Turn-off Drain-source Voltage Slope



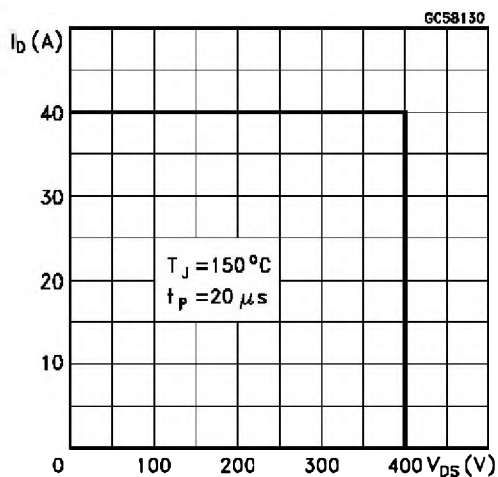
Cross-over Time



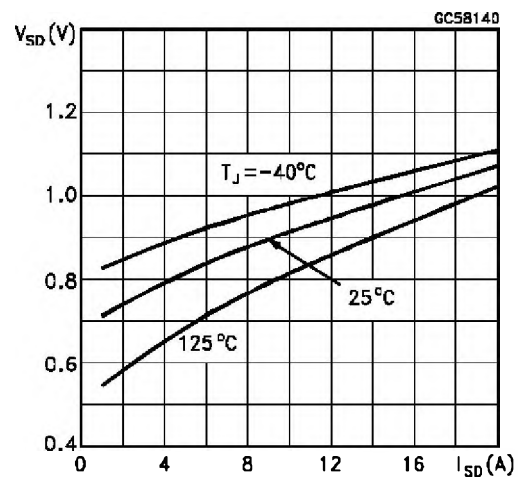
Switching Safe Operating Area



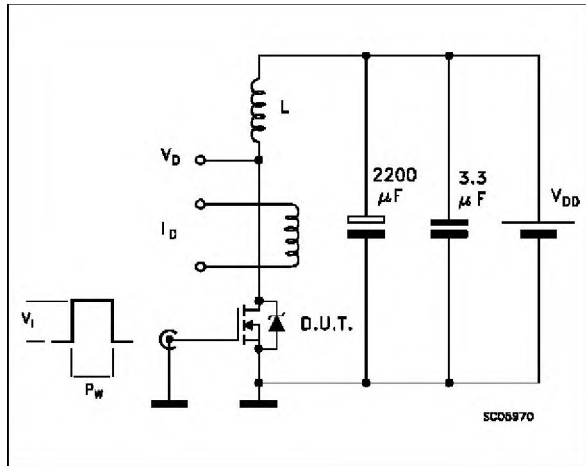
Accidental Overload Area



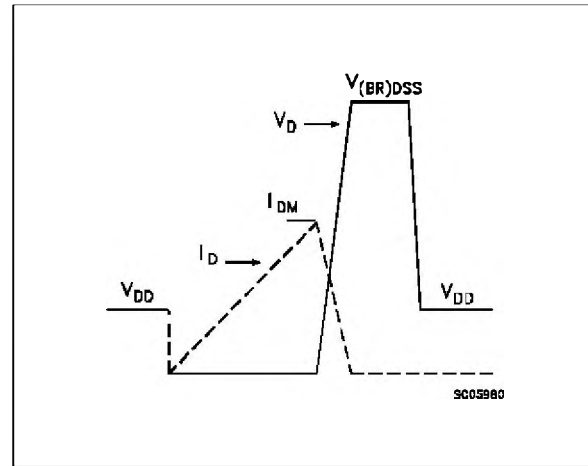
Source-drain Diode Forward Characteristics



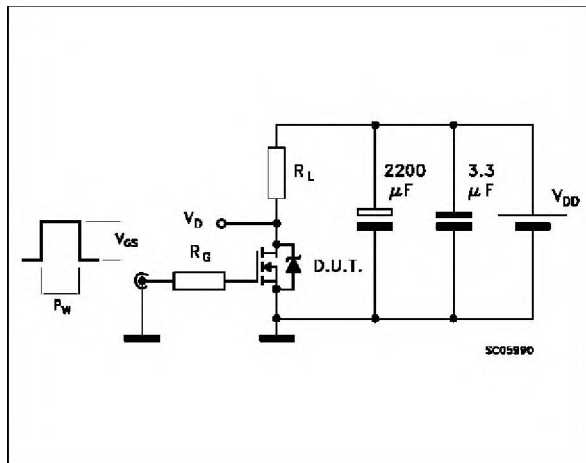
**Fig. 1: Unclamped Inductive Load Test Circuits**



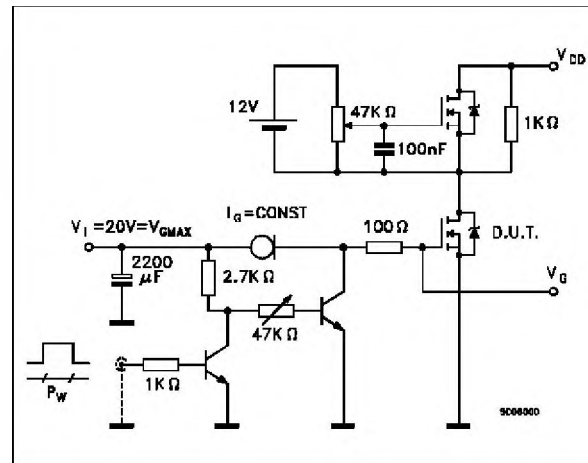
**Fig. 2: Unclamped Inductive Waveforms**



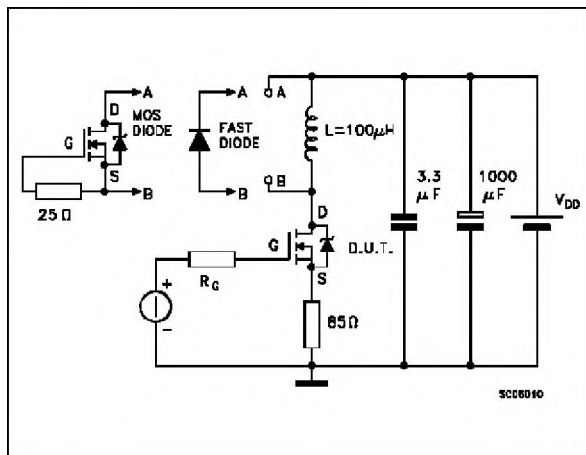
**Fig. 3: Switching Times Test Circuits For Resistive Load**



**Fig. 4: Gate Charge Test Circuit**

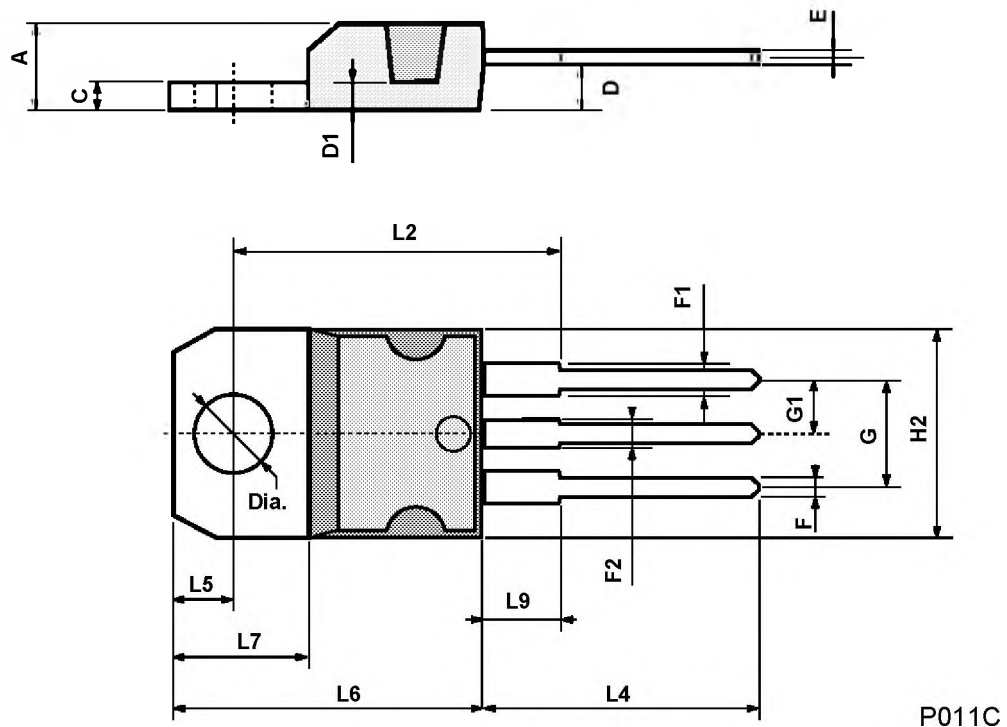


**Fig. 5: Test Circuit For Inductive Load Switching And Diode Reverse Recovery Time**



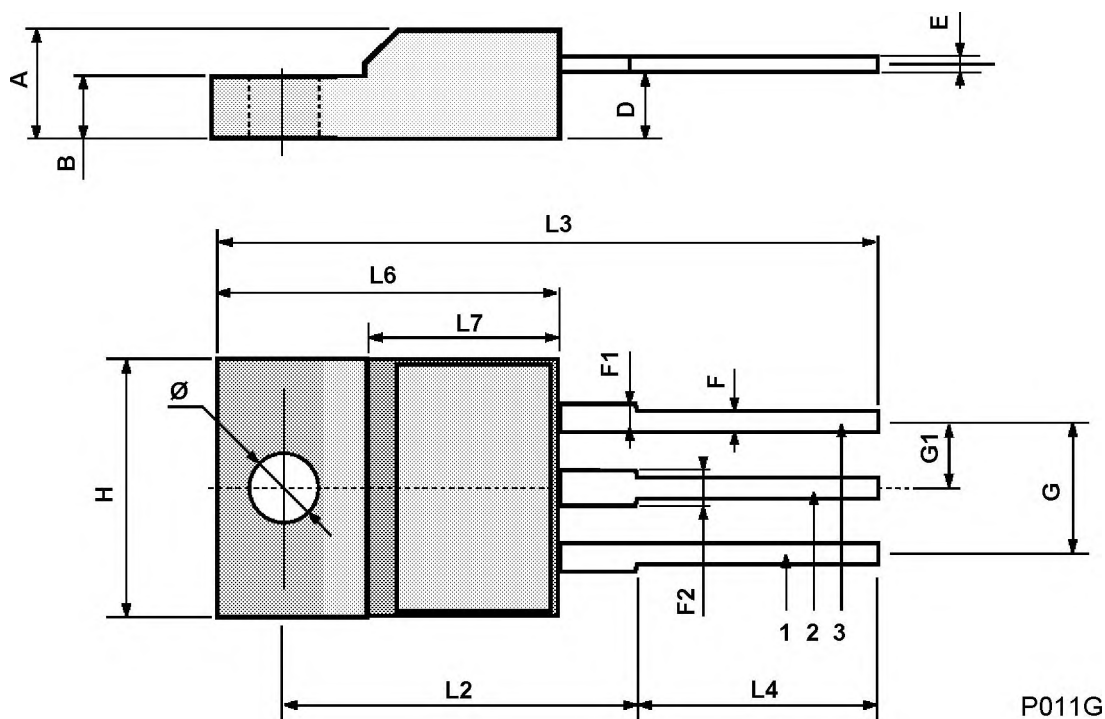
## TO-220 MECHANICAL DATA

| DIM. | mm    |      |       | inch  |       |       |
|------|-------|------|-------|-------|-------|-------|
|      | MIN.  | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.40  |      | 4.60  | 0.173 |       | 0.181 |
| C    | 1.23  |      | 1.32  | 0.048 |       | 0.051 |
| D    | 2.40  |      | 2.72  | 0.094 |       | 0.107 |
| D1   |       | 1.27 |       |       | 0.050 |       |
| E    | 0.49  |      | 0.70  | 0.019 |       | 0.027 |
| F    | 0.61  |      | 0.88  | 0.024 |       | 0.034 |
| F1   | 1.14  |      | 1.70  | 0.044 |       | 0.067 |
| F2   | 1.14  |      | 1.70  | 0.044 |       | 0.067 |
| G    | 4.95  |      | 5.15  | 0.194 |       | 0.203 |
| G1   | 2.4   |      | 2.7   | 0.094 |       | 0.106 |
| H2   | 10.0  |      | 10.40 | 0.393 |       | 0.409 |
| L2   |       | 16.4 |       |       | 0.645 |       |
| L4   | 13.0  |      | 14.0  | 0.511 |       | 0.551 |
| L5   | 2.65  |      | 2.95  | 0.104 |       | 0.116 |
| L6   | 15.25 |      | 15.75 | 0.600 |       | 0.620 |
| L7   | 6.2   |      | 6.6   | 0.244 |       | 0.260 |
| L9   | 3.5   |      | 3.93  | 0.137 |       | 0.154 |
| DIA. | 3.75  |      | 3.85  | 0.147 |       | 0.151 |



## ISOWATT220 MECHANICAL DATA

| DIM. | mm   |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |      | 4.6  | 0.173 |       | 0.181 |
| B    | 2.5  |      | 2.7  | 0.098 |       | 0.106 |
| D    | 2.5  |      | 2.75 | 0.098 |       | 0.108 |
| E    | 0.4  |      | 0.7  | 0.015 |       | 0.027 |
| F    | 0.75 |      | 1    | 0.030 |       | 0.039 |
| F1   | 1.15 |      | 1.7  | 0.045 |       | 0.067 |
| F2   | 1.15 |      | 1.7  | 0.045 |       | 0.067 |
| G    | 4.95 |      | 5.2  | 0.195 |       | 0.204 |
| G1   | 2.4  |      | 2.7  | 0.094 |       | 0.106 |
| H    | 10   |      | 10.4 | 0.393 |       | 0.409 |
| L2   |      | 16   |      |       | 0.630 |       |
| L3   | 28.6 |      | 30.6 | 1.126 |       | 1.204 |
| L4   | 9.8  |      | 10.6 | 0.385 |       | 0.417 |
| L6   | 15.9 |      | 16.4 | 0.626 |       | 0.645 |
| L7   | 9    |      | 9.3  | 0.354 |       | 0.366 |
| Ø    | 3    |      | 3.2  | 0.118 |       | 0.126 |



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